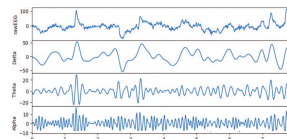


# Can EEG Theta Power Inform Us About Reading Impairment and Phonological Awareness?

Soujin Choi, Silvia Clement-Lam, Elaine Kwok, Brittany Manning, Sean McWeeny, Julia Nikolaeva & Elizabeth S. Norton  
Department of Communication Sciences and Disorders, Northwestern University, Evanston IL, USA

## Introduction

- Given the role of phonological awareness (PA) in reading ability, what are its neural correlates?
- Resting state EEG is thought to represent the brain's preparedness for processing stimuli as well as intrinsic neural activity<sup>1</sup>
- Theta activity** (EEG oscillations in 4-7Hz range) is associated with phonological processing when listening to speech<sup>2</sup>
- A small number of previous studies examined *multiple* EEG bands during resting state<sup>3,4</sup>:
  - didn't report or used few epochs
  - found inconsistent results of reading ability group differences in theta



## Research Questions

- Does resting EEG theta power differ between groups of children who are typical vs. impaired readers?
- Does resting theta power relate to a continuous measure of phonological awareness in children?

## EEG Recording and Processing

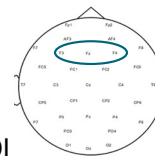
### Recording

- Continuous EEG recorded with Biosemi ActiveTwo EEG system and 32-channel active electrode cap
- Participants looked at a white '+' on a black screen for >4 minutes during recording



### Processing

- A priori* focus on frontal theta (4-7Hz), single temporal/spatial ROI
- Used MATLAB-based automatic processing pipeline optimized for developmental data (MADE)<sup>5</sup>

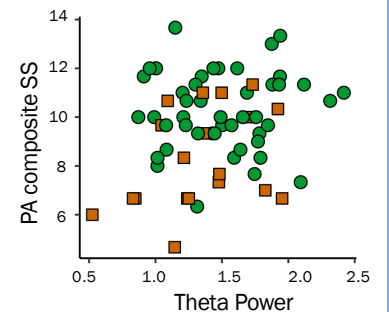
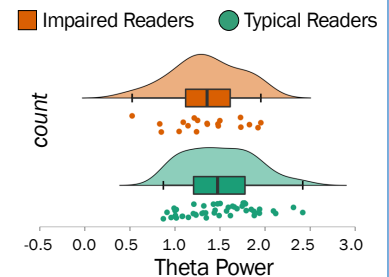


### Usable Data

- All participants had minimum of 40 clean 1-sec epochs analyzed (M=194, SD=60, range 43-346)
- No difference between groups

## Results

- Reading ability groups did not differ in theta power,  $F(1, 61) = 0.85$ ,  $p = 0.36$  (ANCOVA controlling for age, non-verbal IQ, and # artifact free epochs)
- Continuous PA scores did not correlate with theta power,  $r(66) = 0.12$ ,  $p = 0.36$  (Spearman Correlation controlling for age, non-verbal IQ, and # artifact-free epochs)



## Participants

- 66 children, oversampled for dyslexia
- Impaired Readers defined as SS of 90 or below on at least 2 of 4 word reading measures

	Typical Readers	Impaired Readers
N, % female	47, 49%	19, 42%
Age (years;months)	9;8 (10m)	9;11 (9m)
Non-verbal IQ (WISC-V)	11.5 (2.2)	10.3 (2.1)
Phonological Awareness Composite* (CTOPP-2)	10.3 (1.6)	8.3 (2.0)
Untimed Nonword Reading* (WJ IV)	110.8 (10.2)	80.9 (12.7)
Untimed Word Reading* (WJ IV)	115.4 (15.2)	88.3 (11.5)
Timed Nonword Reading* (TOWRE-2)	104.6 (13.0)	77.5 (11.5)
Timed Word Reading* (TOWRE-2)	108.7 (14.5)	78.3 (7.4)

\*group differences  $p < .001$

## Discussion

- Null findings using rigorous methodology (relevant covariates, large amount of EEG data, *a priori* analyses) suggests the importance of employing consistent research methods across resting state EEG studies
- PA skills may only be related theta power when theta is measured during specific cognitive tasks (i.e., rhyming task, auditory processing) and not at rest

## References / Contact

- Snyder, A. Z., & Raichle, M. E. (2012). *NeuroImage*, 62(2), 902-910.
- Goswami, U. (2011). *Trends in Cognitive Sciences*, 15(1), 3-10.
- Papagiannopoulou, E. A., & Lagopoulos, J. (2016). *Frontiers in Pediatrics*, 4.
- Rippon, G., & Brunswick, N. (2000). *International Journal of Psychophysiology*, 36(3), 251-265.
- Debnath, R., Buzzell, G., Morales, S., Bowers, M. E., Leach, S., & Fox, N. (2020). *Psychophysiology*, 57(6), e13580.



Contact: Soujin Choi, [soujinchoi@u.northwestern.edu](mailto:soujinchoi@u.northwestern.edu)